



# **Closeout Report on the DOE/SC Status Review of the**

## **Long Baseline Neutrino Facility/Deep Underground Neutrino Experiment (LBNF/DUNE) Project**

**Fermi National Accelerator Laboratory**

**August 11-12, 2016**

**Stephen W. Meador**

**Committee Chair**

**Office of Science, U.S. Department of Energy**

**<http://www.science.doe.gov/opa/>**



# Review Committee Participants

Stephen W. Meador, DOE/SC, Chairperson

## Review Committee

### *Subcommittee 1—Conventional Facilities and Technical Systems*

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Matt Howell, ORNL

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### *Subcommittee 2—ES&H, Cost and Schedule, Project Management*

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## Observers

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1. Has LBNF made satisfactory progress in preparing to execute the CD-3a scope? Are there adequate resources in place to support the work needed for CD-3a? Is the system to track performance associated with these activities in place and functioning?
2. Are the requirements, the design, and the interfaces pertaining to the far site conventional facility (FSCF) CD-3a scope under effective configuration control and management?
3. Is the LBNF/DUNE project appropriately and effectively managed, including risk and contingency?
4. Has the project responded appropriately to the recommendations of the 2015 DOE IPRs that are related to the CD-3a scope?



1. Has LBNF made satisfactory progress in preparing to execute the CD-3a scope? Are there adequate resources in place to support the work needed for CD-3a? Is the system to track performance associated with these activities in place and functioning?

**Yes. Interfaces with DUNE are under control and there are no significant CD-3a issues.**

2. Are the requirements, the design, and the interfaces pertaining to the far site conventional facility (FSCF) CD-3a scope under effective configuration control and management?

**Yes.**

4. Has the project responded appropriately to the recommendations of the 2015 DOE IPRs that are related to the CD-3a scope.

**Yes.**



### 2.1.1 Findings

- DUNE leadership appears to lack diversity.
- The scope and schedule for ProtoDune are both challenging. Both ProtoDunes are large scale experiments.
- DUNE intends to organize component production around consortia of universities.
- DUNE plans to provide AC power from a single 500 kVA transformer for each detector.
- The 35 ton prototype experienced significant noise problems.

### 2.1.2 Comments:

- DUNE should consider an explicit program for gender balance and diversity within DUNE.
- DUNE has made excellent progress on addressing previous recommendations.



- The ProtoDune beam test time is limited by CERN LS2. ProtoDune results are necessary for the CD-2 review, but cosmic ray results should be sufficient if necessary. The DOE response to a previous recommendation for adequate U.S. participation in ProtoDune seems good.
- Component production will need significant attention to QA and procedures.
- LBNF and DUNE should review the detector transformer choice for noise isolation and spares requirements.
- The noise issues appear to divide into two classes: relatively small and understood issues with the cold electronics; and significant issues with grounding and isolation. These issues require serious attention, but do not affect CD-3a.



### 2.1.3 Recommendations:

1. Proceed to CD-3a.



1. Has LBNF made satisfactory progress in preparing to execute the CD-3a scope? Are there adequate resources in place to support the work needed for CD-3a? Is the system to track performance associated with these activities in place and functioning? **Yes**
2. Are the requirements, the design, and the interfaces pertaining to the far site conventional facility (FSCF) CD-3a scope under effective configuration control and management? **Yes**
4. Has the project responded appropriately to the recommendations of the 2015 DOE IPRs that are related to the CD-3a scope? **Yes**





### ■ Findings

- Few changes have been made to the cryogenic/cryostat design for LBNF/DUNE as the engineering effort to refine requirements has progressed which indicates that the design has reached a sufficient level of maturity for this stage.
- The changes to the cryogenic/cryostat design are
  - The thickness of the insulation of the cryostat has been reduced from 0.9m to 0.8m as determined through the detailed engineering of the system.
  - The design of the support steel for the cryostat has been updated to ensure it can be transported through the Ross Shaft.
  - Added lifting eyes to the ceiling in the Central Utility Cavern and the Detector Cavern to facilitate maintenance of selected equipment.
  - The width of the mezzanine on top of the cryostat was widened from 10m to 12m.
- There was a change to the approach of procuring the nitrogen refrigerators. These will now be procured as a design/build through industry with the LBNF/DUNE team issuing a design specification.
- Prototyping efforts are underway. Expect BOD for ProtoDune – Late 2016.



### ■ Comments

- The project team has done an incredible job responding to programmatic funding profile changes.
- Changing the procurement of the nitrogen refrigerators to a design/build contract reduces the engineering effort on LBNF/DUNE and leverages the experience and expertise of industry.
- Prototyping efforts are already yielding feedback to the final design. It is critical to the long term success of the enterprise that this continue.
  - During prototyping efforts, a helium leak check method was developed. After validation, this methodology can be transferred to the full scale cryostat. This is a positive development.
- Continue to progress in formalizing agreements for the non-DOE scope.
- There are additional detailed design iterations being considered for ODH safety such as secondary containment around the liquid argon piping at the base of the cryostat. Exploring these considerations will progress as the project moves towards CD-2.
- Modeling efforts indicate that liquid argon pumps are only required on one side of each cryostat which indicates that cavern sizing is sufficient.



- **Recommendations**
  - Proceed to CD-3A



1. Has LBNF made satisfactory progress in preparing to execute the CD-3a scope? **Yes** Are there adequate resources in place to support the work needed for CD-3a? **Yes** Is the system to track performance associated with these activities in place and functioning? **Yes**
2. Are the requirements, the design, and the interfaces pertaining to the far site conventional facility (FSCF) CD-3a scope under effective configuration control and management? **Yes**
4. Has the project responded appropriately to the recommendations of the 2015 DOE IPRs that are related to the CD-3a scope? **Yes**



## Findings:

- The preliminary design for the CD 3A scope is complete and has received a independent review and ICE. Sixty percent of the final design for the pre-excavation work has been completed. A final design plan has been issued documenting the activities and schedule to complete the final design.
- The RFP for the CM/GC has been prepared and is out for bid. Bids are due August 29, 2016.
- The project has closed out or are in process of completing all previous review recommendations.
- Tasks informing the final design have been completed
  - A blast vibration field study including actual testing/blasting events at the 4850L has been conducted.
  - A drift optimization study
  - The project has acquired easements needed to install and operate the waste rock conveyor system.
  - Waste rock is planned to be disposed in the Open Cut using an overland pipe conveyor system



#### Findings Continued:

- Three separate studies were also performed and their associated reports were submitted separately.
  - Brow Isolation Feasibility study and conceptual design
  - Underground Electrical Substation Relocation Feasibility Study/Conceptual Design
  - Ventilation Analysis
- Logistics workshops have been conducted.

**Comments:**

- The Tailoring Strategy section in the PPEP should be clarified to state that the request for CD-3A approval is based on the preliminary design that has had an independent review and ICE.
- The project should consider further examination of the logistics and development of additional detailed plans. Engage the CM to prepare the logistics plan when the contract is awarded.
- The project should consider working with the SDSTA to refine the method, system, and logistics for maneuvering and/or loading/reloading steel components that inadvertently derailed during transport from the shaft bottom area to the cavern area. The project should consider identification of “pinch points” where materials in transport on mine cars could become iron bound/trapped/stuck due to minimal clearances, (1.5 ft).
- The project should consider developing a list of critical spares for all equipment in each phase including capture of potential schedule delays if spares are not immediately available and capturing of related costs.



- The project should consider making metacarpal gloves and metatarsal boots mandatory during all phases of excavation and construction.
- The project should consider development of cut sequence plans optimize the drilling, shooting, mucking and excavation.
- The project should consider developing a commissioning plan and checklist prior to startup of the overland pipe conveyor/belt system.
- Project should consider installation of a camera system to monitor critical points in the belt system that are not manned.
- The projects should consider standardizing the utility configuration and revising the current design where the configuration is changing from drift to drift incorporating straight consistent runs for future maintenance and emergency tracking/isolation and repairs of pipelines, HVAC, and other associated infrastructure.





U.S. DEPARTMENT OF

**ENERGY**

### **3. Conventional Facilities**

J. Stellern, ORNL/A. Carney retired CONSOL

Subcommittee 1

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#### **Recommendations:**

Proceed to CD-3A.



1. Has LBNF made satisfactory progress in preparing to execute the CD-3a scope? **YES** Are there adequate resources in place to support the work needed for CD-3a? **YES** Is the system to track performance associated with these activities in place and functioning? **YES**
2. Are the requirements, the design, and the interfaces pertaining to the far site conventional facility (FSCF) CD-3a scope under effective configuration control and management? **YES**
3. N/A
4. Has the project responded appropriately to the recommendations of the 2015 DOE IPRs that are related to the CD-3a scope? **YES**



- **Findings**

- Documentation required to support the present stage of the project and CD-3a are complete: NEPA, HAR, ISM Plan, SVAR and Construction Environmental, Safety, and Health Plan.
- Commitments defined in the Environmental Assessment (EA) have been documented and are actively being followed and/or written into contracts
- ES&H staff assigned to the project and SURF are experienced and competent. ESH issues are being considered in the design of facilities and equipment, with scientific objectives being driven through to engineering specifications. Additional ES&H support from both FNAL and partner laboratories is available and being effectively used in evaluating and developing designs and operating plans.
- ESH staff are actively engaged in design reviews across the Project
- Key hiring for both ESH (Field) and QA is in the final stages, with suitable applicants identified



- **Comments**

- CD-3a ESH recommendations from the December 2015 review have been addressed.
- Strong partnership with DOE, SURF and SD SHPO have ensured rock disposition planning and the EA update occurred in a timely manner. The Project with DOE have also implemented a screening process for activities or design processes that may impact the EA.
- ESH staff are actively working with international partners to ensure sub-contractor compliance with worker health and safety regulations for work being performed in the US under contracts being managed by international partners.
- SURF based reliability projects will be managed under their ESH program, which remains appropriately staffed to support those efforts.
- ESH requirements for underground work are defined within the CMGC Request For Proposal (RFP)
- As communication will be essential for project success, a communication strategy is being developed to ensure everyone involved in far site construction understands needs and assumptions, and that documents are flowed through the Web Based Project Management System (WPMS)



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- **Recommendations**
    - Proceed to CD-3a



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2. Are the requirements, the design, and the interfaces pertaining to the far site conventional facility (FSCF) CD-3a scope under effective configuration control and management? **YES**
4. Has the project responded appropriately to the recommendations of the 2015 DOE IPRs that are related to the CD-3a scope? **YES**



- **Findings**
  - Significant changes since CD-3A review 12/2015
  - The base cost estimate for CD-3a scope has increased from \$225M to \$231M.
    - \$4M estimated for escalation- on CD-3a scope
    - \$2M for extended schedule/management –on CD-3a scope
  - The new HEP profile in the years covered by CD-3a (FY17-FY19) is \$50M less than the previous plan.
  - The overall schedule for CD-3A scope remains unchanged since 12/2015
  - Schedule changes responding to the New HEP Profile include:
    - RLS Profile (CD dates same as at the IPR CD-3a review)
      - CD3b – 2QFY19 – Long Lead Procurement - Near Site Embankment
      - CD2/3c – 1QFY20 – Project Baseline and Construction Approval (balance of project)
    - New HEP Guidance
      - CD2/3b – 1QFY20 – Project Baseline and Far Site Construction Approval
      - CD3 – 1QFY21 - Near Site Construction Approval



- **Findings (cont'd)**
  - The FRA-FNAL EVMS was surveyed in March with 4 Corrective Action Requests (CARs) and 10 Continuous Improvement Opportunities (CIOs). A corrective action plan was developed. The project is planning to conduct a FNAL chartered independent surveillance at the end of the CY.
  - The project team has been practicing the full suite of EVMS tools and reports since the conclusion of the FRA-FNAL successful surveillance.
  - Cost Contingency on CD-3a scope has reduced from \$83M at 12/2015 to \$77M. Decreasing from 38% to 33% respectively.
  - Overall project schedule contingency of 18.1 months was calculated. Management viewed this as too low and increased the overall schedule contingency 40 months.
  - Cost contingency has become more back loaded and reduced during the mid-project. It may cause the Near Site construction schedule/progress rate, which is the major work element during that time frame, to be reduced.
  - Planning for Continuing Resolution
    - Impact of 3 month - the basis of the current plan. Workable
    - Impact of 6 months – potentially delays CD-3a scope (start of construction 5 months). No staff loss
    - Impact of full year – potentially delays CD-3a 1 year and impact the entire project





- **Comments**
  - The Project Controls staff are well qualified and have developed robust processes and procedures. They should continue to support the development of the CAMs expertise and familiarity with accruals and variance reporting.
  - A prior recommendation to conduct an independent implementation/readiness review of the EVMS remains open. The project is encouraged to execute their plan to conduct the review in December 16/January 17 in advance of commencement of CD-3a work.
- **Recommendations**
  - Proceed to CD-3a



**RLS PROFILE**

Line Item		
<b>CD-1</b>	Planned: 1Q/2013	10-Dec-2012 (A)
<b>CD-1R</b>	Planned: 1Q/2016	5-Nov-2015 (A)
<b>CD-3a</b>	Planned: 4Q/2016	
<b>CD-3b</b>	Planned: 2Q/2019	
<b>CD-2/ 3c</b>	Planned: 1Q/2020	
<b>CD-4</b>	Planned: 4Q/2030	
<b>TPC % Complete</b>	Planned: 11%	Actual: 11%
<b>TPC Cost to Date</b>	\$127 M	
<b>TPC Committed to Date</b>	\$133 M	
<b>TPC</b>	\$1,457 M	
<b>TEC</b>	\$1,140 M	
<b>Contingency Cost (w/ Mgmt Reserve)</b>	\$317 M	31%
<b>Contingency Schedule on CD-4</b>	40 months	31%
<b>CIP Cumulative</b>	n/a	
<b>SPI Cumulative</b>	n/a	



## 6. Management

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2. Are the requirements, the design, and the interfaces pertaining to the far site conventional facility (FSCF) CD-3a scope under effective configuration control and management? **YES**
3. Is the LBNF/DUNE project appropriately and effectively managed, including risk and contingency? **YES however the new funding profile does not support the currently planned obligation profile with sufficient contingency within each FY**
4. Has the project responded appropriately to the recommendations of the 2015 DOE IPRs that are related to the CD-3a scope? **YES**



### Findings

- The project received a revised funding profile at the end of July that reduces the funding available in FY18-FY23 and reduces the annual peak funding of 180 to 166.

	Prior Yrs	FY16 \$M	FY17 \$M	FY18 \$M	FY19 \$M	FY20 \$M	FY21 \$M	FY22 \$M	FY23 \$M	FY24 \$M	FY25 \$M	FY26 \$M	FY27 \$M	Total \$M
Feb-16	121	26	45	110	150	180	180	180	180	160	102	23	0	1457
Jul-16	121	26	45	95	135	160	165	166	166	166	135	105	51	1536
Delta	0	0	0	-15	-15	-20	-15	-14	-14	6	33	82	51	79

- The project has not performed a bottom's up assessment of the impact of these changes on the total project but is estimating that the TPC will be increased by \$79M without any impact on the CD-4 date or the 40 months of schedule float that precedes it. The project plans to complete the quantitative assessment by September 2016.
- The project has evaluated the impact of a 3, 6 and 12 month CR and identified ways to mitigate the impact in all but the 12 month CR scenario with one exception. The consequences of a GM/GC base estimate that exceeds the \$800K currently in the plan are unknown but could have severe impacts, even under the 3 month CR condition.



- **Findings (cont'd)**

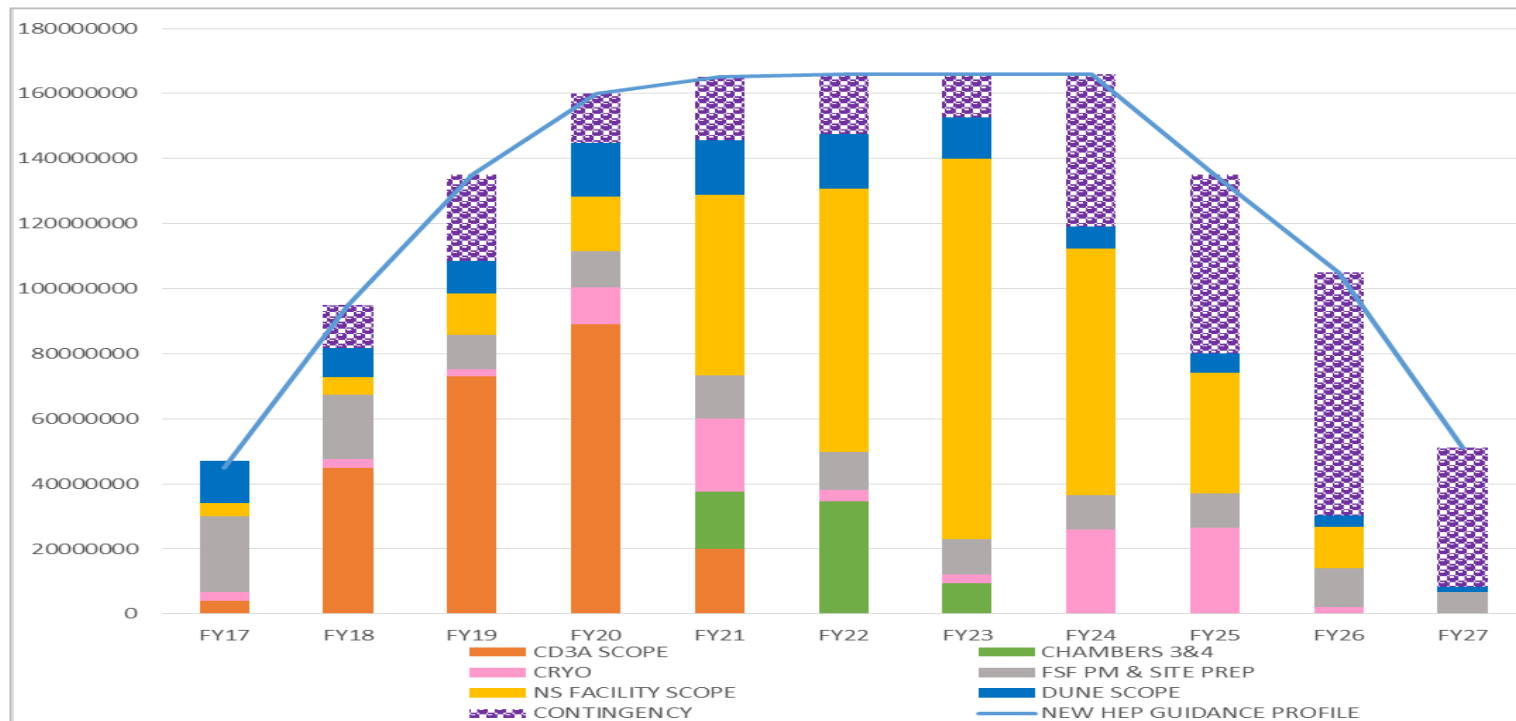
- The project risk register identifies 143 risks, 60% of which are evaluated as being low or negligible risks. Of the 12 high risks, 3 of those pertain to the CD3a scope with the largest cost impact being a risk associated with escalation estimates in the amount of \$4.7M. Of the remaining 26 risks pertaining to the CD3a scope, 8 are assessed as medium risks and 18 as low risks.
- The risk register does not identify trigger dates, expiration dates or pre and post mitigated impacts
- The risk register includes a substantial amount of detail about each risk and identifies the associated reference documents in Docdb.
- The PPEP suggests that the critical decision milestones are Tier 1 milestones without explicitly saying so and the references to control and approval for Tier 0 milestones on page 10 are not clear. The PMP states that T0 milestones are those approved by the PME; the PPEP has no reference to T0 milestones.
- The project has not identified a KPP that requires a detector at the far site measure a neutrino generated from FNAL.
- The PMP, updated in July 2016, refers to both DUNE/LBNF and LBNF/DUNE



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- **Findings (cont'd)**
  - The project presented the current obligation profile relative to the revised funding profile that leaves the contingency back-loaded and with the amount of contingency in FY26 and FY27 exceeding the value of the work that is planned for those years





- **Comments**

- The project management team is strong and, with the exception of a few key hires that are either in progress or planned for the next few months, is appropriately staffed to bring this project to successful completion.
- The project should be commended for their quick assessment of the impact of the lately revised funding profile and their thoughtful assessment of which scope could be delayed without impacting the overall project schedule.
- The project should also be commended for carefully identifying, in all the presentations, the source of the data being presented. With data from essentially two different profiles (RLS and new), the presentations could easily have been incredibly confusing.
- As presented, the contingency reserve by fiscal year associated with the obligations for the CD-3a scope with the newly revised HEP funding profile is not consistently adequate in FY17-FY21. The project will need to reschedule additional work into the future in order to have ensure successful execution of the CD-3a scope.
- Until the scope to be delivered by the LBNF/DUNE-US project is identified, the project should make every effort to retain the 40 months schedule contingency.



- **Comments (cont'd)**

- Both the PPEP and PMP need to be revised to ensure consistency between the two documents.
- Both the PPEP and PMP reflect the fact that they have evolved over several years with several different authors. Both could benefit from a scrub to make the writing styles consistent, at least within a single document. Additionally there is narrative that might be stated more concisely. This could reduce the length of the documents and make them easier to keep current.
- Table 6 in the PPEP refers to changes that are “Major changes in technology or in approach”. While the current project staff may understand which changes would meet that criteria, this is very open to interpretation. This lack of clarity could cause unnecessary complications in the future, particularly if/when members of the IPT change.
- The risk register contents appear overpopulated to the point of being burdensome and should be revised and reduced and should include key elements such as trigger dates and risk expiration dates. Even though this information can be extracted from the schedule, having all the information about a risk in a single source database will be helpful. The project should evaluate the benefit of including pre and post mitigation impact values.





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- **Comments (cont'd)**

- The project's concerns regarding the ramifications of a 12 month CR are well warranted
- It is apparent that the project benefitted from the multiple reviews and comprehensiveness of the RFP.
- The project is considering adding a project advisory committee for LBNF and this should be pursued to provide high level guidance for the project.
- The project team has proven very resourceful in pursuing outside financial assistance and should continue to pursue and potential funding opportunities.
- A senior level Quality Assurance (QA) Manager has been hired and will be a benefit the project.
- The project should firm up the KPP deliverables and requirements once the DOE- funded scope has been finalized.
- The FNAL project team is working to have the A/E contract currently under the control of SDSDTA assigned directly to FNAL. This will better ensure the necessary level of coordination between the CM/GC and the A/E that is essential for the success of the project.
- The FNAL team is commended for application of the CM/GC approach, which is widely accepted in the private sector, for the execution of the LBNF Project. This approach has been demonstrated to minimize cost and schedule risk during project execution by establishing an owner, A/E, CM partnership that allows focus on attaining stated mission goals.



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- **Comments (cont'd)**

- FNAL project team should consider parallel reviews of submittal and RFI's by the A/E, SDSTA, and FNAL, with final disposition to be provided by FNAL. Additionally, given that different organizations have varying past experiences with regard to submittal/RFI review and approval, the FNAL project team should consider a pre-construction work shop to "practice" processes for review and approval of submittals and RFI's.
- Evaluation of an approach for commissioning of the completed effort will be a factor in the evaluation of proposals for CM/GC services. It is currently not planned to have the commissioning entity participate in the design process. This appears to be an acceptable approach given the low level of complexity of systems and components to be commissioned.
- Since the time of the last review, the FNAL project team has made significant progress with the approach for procurement of construction services. The recent procurement staff hires have had a significant positive impact on the project.
- The approach of the FNAL project team to have procurement staff located at the far site location will ensure the efficiency of the contract administration process and reduce the likelihood of breaks in the continuity of work.
- As the CM/GC contract for construction will not include contingency in the contract value, the FNAL project team and DOE project/procurement staff should have a workshop on the step-wise processes to be employed to expeditiously disposition contract change actions in a manner that will not delay construction activities.



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- **Recommendations**

- Develop an obligation profile that can be supported by the revised funding profile with adequate contingency/year for the CD3a scope until the time when the project feels that the bulk of the uncertainties related to contract awards and construction activities have been retired before CD-3a.
- Revise the PPEP to address the comments before CD-3a.
- Update the PMP to ensure it is consistent with the PPEP by the next IPR.
- Consider adding trigger dates, expiration dates and pre and post mitigated impact information to the risk register by the next IPR